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# TRANSLATION

SCIENTIFIC-TECHNICAL CONFERENCE ON HIGH-STRENGTH METALS, STEELS, AND ALLOYS

By

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# SCIENTIFIC-TECHNICAL CONFERENCE ON HIGH-STRENGTH METALS, STEELS, AND ALLOYS

O. A. Bannykh

On April 2 and 3, 1962 a scientific-technical conference on the theoretical and experimental investigations of high-strength metals, steels, and alloys took place at the Baykov Metallurgical Institute in Moscow. Thirty-two reports were heard and discussed.

The report of academician G. V. Kurdyumov on the influence of micro-deformations, grain substructure, and the properties of crystals on strength should be noted.

Ye. G. Ponyatovkiy's report related data about the influence of high manifold pressures on the phase boundary positions, the phase diagram and on the fine structure of metals and alloys.

Academician N. S. Akulov gave a report on the kinetic theory of dislocations and its application to the strength and superstrength of metals.

The report of B. Ya. Lyubov and A. L. Roytburd was devoted to an analysis of the dislocation movement in defect-free and crystal lattices.

L. A. Boloshina and V. M. Rozenberg investigated the influence of

orientations and single crystals of aluminum on creep. They pointed out that the occurrence of slip along several families of planes in the near-boundary regions can lead to hardening of near-boundary regions at room and low temperatures, and to an increase of their deformation magnitude at elevated temperatures.

I. B. Kushnir and Yu. A. Osip'yan reported on the structure of iron microcrystals having a small dislocation density. The authors' method enabled them from, the shift of the etch figures, to observe movement of dislocations induced by an applied load.

I. A. Oding and I. M. Kop'ev reported on the results of an experimental investigation of the sturcture and strength of threadlike crystals (whiskers) of a mixture of copper and iron. They investigated the influence of small quantities of additives on the strength of copper whiskers obtained by deoxidation of a percent of additives adversely affected the strength of the whiskers. The tensile strength of the whiskers from mixtures is from 50-400 kg/mm$^2$, decreasing with an increase of the whisker diameter. The structure of the cross section of the whisker has been established and consists of three layers: 1) central copper core (HV 82), 2) the intermediate (the finely dispersed mixture of copper and iron, HV 546), 3) peripheral (plastic mixture of copper and iron HV 140-192).

The strength of the whiskers is determined by the dimensions of the intermediate layer.

The report of S. Z. Bokshteyn and I. A. Svetlov was devoted to the prospects of developing high-strength stable structural materials on a base of threadlike crystals. The authors think that threadlike crystals will find application as materials similar to glass fiber which has been impregnated by plastics. In such compositions the portion of whiskers will be up to 80%. As a binder we can use phenols,

silicons polyesters (for work up to 300°), boron polymers (for work up to 500-600°) or metals (for work up to 1000°). Whiskers from boron carbide, metallic beryllium, silicon carbide, sapphire, and graphite are prospective materials for reinforced fibers.

The results of tensile tests of whiskers of nickel, copper, and cobalt were presented by S. Z. Bokshteyn, S. T. Kishkin, and I. A. Svetlov. It was pointed out that the ultimate tensile strength of crystals 3-4μ thick is 250-330 $kg/mm^2$, and at a thickness of 13-15μ the tensile strength decreases to values characteristic for usual single crystals.

V. M. Amonenko, B. M. Vasyutinskiy, G. P. Kartmazov, I. I. Papirov, G. F. Tikhinskiy and V. A. Finkel' investigated threadlike crystals of chromium and beryllium. The obtained threadlike crystals were up to 10 mm in length, a cross section area of $1 \cdot 10^{-2} - 1 \cdot 10^{-4}$ $mm^2$ (for beryllium) and $1 \cdot 10^{-2} - 5 \cdot 10^{-6}$ $mm^2$ (for chromium) and had a polygonal shape. A maximum tensile strength 270 $kg/mm^2$ was obtained from samples with a cross section of $2 \cdot 10^{-5}$ $mm^2$.

In several reports the structure and strength of metallic films condensed in a vacuum were examined (L. A. Palatnik, G. V. Fedorov, A. I. Il'inskiy, L. S. Palatnik, M. Ya. Fuks, B. G. Boyko and others). The high strength of the condensed films was caused by the nature of the substructure. The dimension of the coherent areas in the aluminum and silver films is close to the dimension of mosaic blocks in deformed polycrystals and their degree of block disorientation is close to the degree of crystallite disorientation in bulk polycrystals. At the conference much attention was paid to the thermomechanical treatment of steel.

The influence of high-temperature thermomechanical treatment (H.T.M.T.) with the use of rolling on the heat-resistant properties of nickel-and iron-base austenite alloys was investiagted by V. D. Sadovbkiy, S. N. Petrov, Ye. N. Sokolkov, M. G. Gaydukov, D. Ya. Kagan, and L. V. Smirnov. The rolling temperature of a nickel-base alloy was 200-250° higher than the recrystallization temperature. The obtained structure had evident serration of the grain boundaries. The hardening effect of H.T.M.T. for the investigated alloys was observed at 550-650° but was not detected at 750°. The causes of strengthening of the alloys by means of H.T.M.T. are considered by the authors to be a decrease of the dimension of the coherent scattering area, development of microdeformations in the crystal lattice, and distortion of the grain boundaries (serration).

The theme of the report of Ye. N. Sokolkov, M. G. Lozinskiy, and N. P. Chuprakov was the investigation of the mechanism of a hot plastic deformation of austenitic steels and alloys of type NiMoNic upon H.T.M.T. By means of usual and polarizing microscopes the authors investigated shear formation and pointed out that this process is accompanied by a diffusion movement of the grain boundary regions and by the appearance of serration.

M. G. Lozinskiy in his report "The Influence of a Particular Structural Condition upon H.T.M. T. by Rolling on the Properties of Heat-Resistant Nickel" classified the methods of hardening metals and alloys by combining heat treatment and machining, having pointed out the merits and deficiencies of these methods. It was pointed out that for nickel the dimension of the substructural blocks, forming upon H.T.M.T., is virtually independent of the rolling temperature, being $1-0.7 \cdot 10^{-4}$ cm, and the microstresses diminish with a rise of

temperature from 35.9 kg/mm$^2$ at 500° to 20.4 kg/mm$^2$ at 900°.

A. P. Gulyayev and A. S. Shigarev reported on thermomechanical treatment (T.M.T.) of steel with 0.5% C; 1.5% Cr; and 4% Ni. The authors studied the strength, ductility, and impact strength relative to the temperature and extent of deformation. They pointed out that the strength of steel increases as the extent of deformation increases, from 240 kg/mm$^2$ (without deformation) to 275 kg/mm$^2$ at about 90% deformation. The authors think that one of the reasons for the increase of the strength of steel upon T.M.T. is the separation of carbon from austenite.

L. I. Kogan, V. I. Sarrak, and P. I. Entin reported on the influence of austenite deformation on the properties of steel after hardening . They came to the conclusion that diminuation of austenite crystals upon T.M.T. is not a factor which determines an increase in strength. The experiments pointed out that there is a linear dependence between austenite hardening as a result of deformation and the strength of the hardened steel.

The following reports were devoted to the thermomechanical treatment of steel: L. M. Butkevich, M. B. Makogon, V. Ye. Panin, and T. S. Sidorova's "Thermo-Stability Increase of Spring Materials by the T.M.T. Method". and Yu. A. Sysuyev, B. A. Apaev's "Investigation of the Effect of Deformation at Elevated Temperatures on the Change of Phase Composition of Carbon Steel With Different Starting Structures."

K. A. Malyshev and N. A. Borodina reported on the hardening of austenite alloys by the method of phase work hardening (direct and inverse martensite transformation). The degree of hardening depends on the quantity of martensite taking part in the transformation, and the original yield point of the austenite. Heating the alloys to the tempera-

ture of austenite recrystallization eliminates the hardening effect of phase work hardening.

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